Dangers (The) of Impure Ice
Mineral. Soc. of Boston.

THE DANGERS OF IMPURE ICE.

REPORT TO THE

Sanitary Protection Association of Newport, R. I.,

UPON THE

PURITY OF THE ICE SUPPLY FROM ALMY'S POND.

By Profs. RAPHAEL PUMPELLY, of the U. S. Geological Survey (Chairman), WM. B. HILLS, of Harvard University, and Dr. H. R. STORER.

Reprint from THE SANITARIAN, for May, 1882.

The Committee appointed to examine, for the benefit of the Newport Sanitary Protection Association, into the quality of the ice supply from Almy's Pond, has to report as follows:

Your Committee has examined the pond and its surroundings, and find that besides a certain amount of agricultural drainage, it also receives the local seepage from a number of barn-yards and privies, and also the direct drainage of the overflow from a number of cesspools belonging to houses situated on the west side of Bellevue Avenue, and south of Wheatland Avenue, which finds its way to the pond by a drain running through Wheatland Avenue.

Samples of water and of ice were taken by the Secretary of the Association, Lt. Com. Stedman, when it was being cut upon the pond. These samples were submitted to Prof. W. B. Hills, of the Harvard Medical College, Boston, analyst of the Association (Prof. Hill's Report is attached hereto as Appendix A.)

It is proper to say, with regard to chemical analyses of water or of ice, that in the present condition of our knowledge of the subject, neither chemical analyses, nor, in most cases at least, microscopic investigations, are able to point out specifically the causes of epidemic diseases produced by the use of infected waters.

The whole weight of the evidence produced by modern investigation is in favor of the existence of a close genetic relationship between the presence of certain low forms of vegetal life and the epidemic prevalence of many diseases, both of mild and fatal kinds.

This evidence also shows very conclusively that the germs of these forms, which have produced or accompanied the disease in the human body, retain their capacity for infection after having been excreted.

It becomes, then, important to know whether the germs can retain their vitality and specific adaptability for infection after having passed into the condition of sewage, and under conditions of varying temperature, moisture and dryness.

Experiments made by Pasteur and other biologists have shown that while the adult forms of bacteria are killed by variations of a few degrees of temperature, their germs will often withstand a temperature

of boiling water on the one hand, and many degrees below freezing on the other. Under the conditions of moisture and nourishment they develop rapidly-succeeding generations; while, on the other hand, they may remain in a dried condition for many years, to be brought again into activity when subjected to moisture.

There is, therefore, little doubt that when they accompany sewage matter they go wherever this goes, excepting where the sewage frees itself from its impurities by percolation through a filtering medium.

The experiments made by the Chairman of your Committee and his associate, Dr. Smyth, for the National Board of Health have proved conclusively that even extremely fine sand possesses no filtering capacity for the germs of these low forms of life, and that most soils possess such filtering power *only to a slight extent.* Thus in nearly all cases these germs must accompany the water from the beginning of its journey, from the cesspool, to its end in the stream or pond or ocean, excepting where taken up to sustain plant life.

The value of chemical analysis is largely shown in this, that it detects the presence of an abnormal amount of organic matter; this matter may be harmless or it may indicate the presence of sewage, and in any event should lead to an examination to determine its source.

Prof. Hills has pronounced the water unfit for drinking purposes, and there can be no doubt that as far as the question of drinking water is concerned, any pond of the dimensions and depth of Almy's Pond, which receives even the present amount of sewage that flows into it, should be pronounced dangerous for this reason alone, and still more so, from the possibility that at any time this sewage may contain contribution from sources contaminated by typhoid fever or other zymotic diseases.

The next question that your Committee has to consider is this:

Does water in the act of becoming ice free itself from impurities?

Water in freezing undoubtedly frees itself from substances which in solution will necessarily give a fluid of a specific gravity greater than water alone, and also from those fluid substances which require a lower temperature for congelation.

But even in these cases the frozen water retains traces of these substances more or less entangled throughout its mass and solid particles floating in suspension or entangled in the ice, and these vary in size from a floating carcase, or fœcal matter, down to the extremely minute germs of infectious bacteria.

Experiments have been made for your Committee to determine whether pond ice contains living germs.

Ice taken with great care from the centres of blocks and introduced into sterilized infusions of beef produced rapid putrefaction, thus giving a positive affirmative answer.

There can be no doubt that whatever objection attaches to the use of contaminated drinking water, attaches equally to ice frozen from it.

Indeed the objection would seem to be greater to the ice.

For, dead organic matter entering water during the warm season, is decomposed and more or less used up to nourish plant and animal life; while in winter the low temperature preserves it, thus permitting an accumulation which, floating near the surface, may supply a more foul water for the ice.

This supposition is confirmed by Prof. Hills' analyses, as will be seen from the following remarks by Dr. Gooch, Chemical Assistant of the U. S. Geological Survey, to whom I submitted the analyses for an opinion on this point:

"It may be inferred from a comparison of these analyses that a considerable, though varying proportion, of the impurities of the water are included in the ice which forms on its surface. It follows at once, of course, that unless it can be shown that germs of disease are not subject to inclusion like ordinary forms of matter, the ice from water contaminated with sewage must be unfit for use.

"It is noteworthy that the amount of *albuminoid ammonia* in the ice from Almy's Pond is slightly in *excess* of that found in the water. The proportion, too, of the total volatile residue of the ice to that of the water is unusually large."

In view of the fact that Almy's Pond is already contaminated by direct inflow of sewage, your Committee recommends very strongly to all members of the Association that they avoid the use of ice from that source for all purposes, even for refrigerators.

Your Committee finds that Lily Pond is singularly free from all the objections that attach to Almy's Pond, and recommends the ice therefrom.

We would add that a representative of the Newport Ice Company (the lessees of Almy's Pond) has stated that the Company is anxious to act to any reasonable extent with the Association in insuring a supply of pure ice.

Appended to this report will be found the following documents:

Appendix A. Report of Professor W. B. Hills.

" B. } Communications from Dr. H. R. Storer, a member
" C. } of this Committee, to Ex-Mayor Burdick, its former Chairman.

Respectfully submitted,

RAPHAEL PUMPELLY, *Chairman of the Committee.*

APPENDIX A.

Harvard Medical College, Chemical Laboratory,
Boston, February 3, 1881.

E. M. STEDMAN, Secretary Sanitary Protection Association, Newport,

SIR: I enclose to you the results of my analyses of samples No. 10 (water from Almy's Pond), and No. 11 (melted ice from Almy's Pond), received from you January 18, 1881. The analyses were made the following day.

There is, as I understand it, no question in regard to the suitability or non-suitability of the pond water for direct domestic use. It is well to state, however, that it presents, in general, the characteristics of the water of most small ponds. It contains a large amount of organic matter, indicated in the report, first, by the "albuminoid" ammonia, which is several times larger in amount than it should be in a drinking water; second, by the large organic residue obtained on evaporating the water. The "free" ammonia is also excessively high, and is doubtless derived from the decomposition of organic matter, for the most part.

Most of the organic matter contained in this water is undoubtedly

vegetable matter. Unfortunately it is not possible to say, from the analysis, whether any of it is derived from sewage. We are obliged to depend upon the determination of the chlorine in water, to decide whether organic matters are animal or vegetable. If, with the large amount of "free" and "albuminoid" ammonia which we find in this water, we also find a large amount of chlorine, *which cannot be due to natural causes*, we should say at once that the water is contaminated with sewage. But all Newport waters contain considerable chlorine, on account of their proximity to the sea. The large amount in this water is derived chiefly from the sea, without any doubt, and we cannot say but that it all is. The chlorine then affords us no solution of the problem. In this particular case, however, the question of chlorine is of no great importance perhaps, for, if we assume that *all* the organic matter is of vegetable nature, the amount is sufficient to condemn the water for direct use.

We know that a certain amount of sewage is entering this pond. It is possible that, if this pond was outside the influence of the sea, the amount which has thus far entered may not have been sufficient to render its presence known by any excessive amount of organic matter, or any marked increase of chlorine. It is diluted to a great extent on entering a large volume of water, and may be diluted so far as to be beyond the reach of chemical analysis at present. But it would not be safe to say that it is harmless, simply because it is diluted to a certain extent. Moreover this pond is shallow and of limited area, and it is only a question of time, if sewage continually enters it, when the presence of sewage becomes evident to chemical analysis, *i. e.*, on the supposition that it is so far from the sea that the chlorides from the sea cannot enter it. It is also to be borne in mind that the most dangerous contamination of all (that due to the germs of diseases) cannot be detected by any means. Should typhoid fever break out in the settlement which empties its sewage into this pond, it would be impossible to detect the typhoid germ in the water. It would not, I think, be possible to find many scientific men who would not say that the water was unfit, under such circumstances, for drinking purposes. The possibility, then, of such a condition of things, should lead us to abandon the water.

I have spoken at some length of the fitness of this water for drinking purposes, because I do not consider it proper to take ice for consumption from a pond, the water of which is unfit for drinking purposes. Even if ice purified itself by freezing, I should still be opposed to taking the ice from such a pond on principle. It is a fact, however, known now to all scientists, that ice does not completely purify itself by freezing. If the ice is from a shallow pond, containing much floating organic matter (vegetable), it may become mechanically enclosed by the ice, and when the ice is melted, may be seen in the form of *suspended* matter. Melted ice may, however, contain a considerable quantity of substances, both organic and inorganic, *in solution*. In proof of this it is only necessary to call your attention to some analyses of ice which I enclose, and which I have taken from some of the Massachusetts State Board of Health Reports. You will notice that even the *filtered* waters contain in solution both organic and inorganic matters, in some cases in considerable amount.

As to the ice from Almy's Pond, but very little need be said if the sample sent me is a fair sample. You will notice from the analysis that it contains a large amount of organic matter, shown by the "albuminoid" ammonia and the organic residue. The "albuminoid" ammonia, even if it was much less than it is, shows a degree of organic contamination sufficient to absolutely condemn it for drinking purposes. The melted ice contains a large amount of organic matter in suspension. This does not settle readily, and much of it would be drunk by persons using the ice as it is ordinarily used for drinking purposes. Even filtering does not remove it entirely. For the filtered water has a white opalescent appearance, due to the presence of a portion of this organic matter in a finely divided form.

Most of the organic matter present in this ice is undoubtedly vegetable. Whether any of it is animal, it is no more possible to say than it was in the case of the pond water, for the chlorine may have been entirely derived from the sea.

The organic matter in the ice is in a more or less decayed condition. The odor perceived when the stopper was removed from the jug was very disagreeable, and is still evident after the jug has remained unstoppered for several days. This fact makes the water still more unfit for use. I think the citizens of Newport can do no better than to try this simple experiment, in order to convince themselves that the ice is contaminated. Break a cake into small pieces, put them into a demijohn, and stopper it up till the ice is melted. If the odor is as marked as in the sample received by me, they can hardly fail to be convinced of the impropriety of using the ice.

If the sample examined is an average one, I should not be surprised if it not only produced bad effects in many of those using it in drinking water, but also had an injurious effect in tainting the atmosphere of the ice-chests in which it will be put by those using it.

I must emphatically advise that it be not used for either purpose.

The analyses of ice which I enclose are intended chiefly to show that ice may contain considerable impurity, and that water is not completely purified by the process of freezing. In regard to No. 1, however, I will say that it is an analysis of the ice used at one of the hotels at Rye Beach, in 1875, and that twenty-six out of about 500 persons using it were rendered seriously ill. The case was investigated very thoroughly, the proprietors of the hotel readily assisting, and the trouble was found beyond a doubt to be due to the ice, and ceased when the use of the ice was discontinued. It is interesting as being the first case where sickness was distinctly traced to the use of contaminated ice.

Of the samples, Nos. 1–5 inclusive, and No. 11 would be considered impure ice.

Very truly yours, WILLIAM B. HILLS.

[Figures express parts per 100,000 of water.]

No. 10. Water from Almy's Pond: Free ammonia, 0.060; "albuminoid" ammonia, 0.048; chlorine, 7.8. Residue—fixed, 13.; volatile, 11.; total, 24.; hardness, 5°.

Water was of the brown color seen in most pond waters, due to vegetable matter in solution. It contained a small amount of suspended material. Much charring on ignition of solid residue.

No. 11. Ice from Almy's Pond: Free ammonia, 0.0066; "albuminoid" ammonia, 0.0496; chlorine, 0.05. Residue—fixed, .5; volatile, 6.0; total, 6.5.

The water from the melted ice contained a large amount of suspended material, and had a very disagreeable odor.

[Figures express parts per 100,000 of water.]

LOCATION.	Free Ammonia.	"Albuminoid" Ammonia.	Chlorine.	RESIDUE.		
				Fixed.	Volatile.	Total.
1. Rye Beach Ice, 1875. Analysis by W. R. Nichols.	*a.* 0.0208	0.0704		7.80	5.72	13.52
1. Do. do. do.	*b.* 0.0213	0.0165	3.23	6.88	2.84	9.72
2. Horn Pond, Dec. 3, 1876. Dr. E. S. Wood	0.0026	0.044	0.4	1.6	7.6	9.2
3. Hammond's Pond, Jan. 23, 1877. Dr. Wood	0.0066	0.019	—	1.	1.4	2.4
4. Jamaica Pond Ice Co., Feb. 12, 1877. Dr. Wood.	0.018	0.016	0.3	0.4	0.4	0.8
5. Do. do. do.	0.026	0.016	0.3	0.4	0.8	1.2
6. Fresh Pond water, Jan. 11, 1878	0.0128	0.0192		9.	3.	12.
6. Fresh Pond ice. S. P. Sharples	0.0060	0.0075		3.50	1.50	5.
7. Spy Pond water. S. P. Sharples.	0.0640	0.0128		13.	4.	17.
7. Spy Pond ice. S. P. Sharples	0.0064	0.0064		3.50	1.50	5.
8. Little Spy Pond water. S. P. Sharples	0.0160	0.0226		7.	4.	11.
8. Little Spy Pond ice. S. P. Sharples	0.0050	0.0060		1.50	1.	2.50
9. Pond Hole, Slaughter House, Fresh Pond water	0.352	0.1472		7.	10.	17.
9. Pond Hole, Slaughter House, Fresh Pond ice	0.0060	0.0090		1.	1.50	2.50
6 to 9 inch=water and ice taken at same time and place. Experiments to see to what extent water is purified by freezing. Prof. Nichols.	*a.* 0.0072	0.0061		0.93	0.58	1.51
10. Silver Lake, Pittsfield, Feb. 21, 1876	*b.* 0.0077	0.0013	0.02	0.30	0.14	0.44
11. Silver Lake, Pittsfield, Jan. 22, 1881. W. B. Hills.	0.0266	0.078	0.37	*a.* 2. *b.* 1.	*a.* 4. *b.* 2.5	*a.* 6. *b.* 3.5
12. Boston Ice Co. W. R. Nichols	0.0045		Less than 0.02	0.45	0.31	0.76

In Nos. 1, 10 and 11, *a*=unfiltered, *b*=filtered.

APPENDIX B.

39 Washington St., Newport, Dec. 22, 1880.

DEAR SIR: I duly received your letter. Ice unfit for ordinary domestic purposes ought to be also unfit for butchers' use, even if only employed so that there is no direct contact with the meats.

The question of ice impurity is evidently quite a new one. The following is all the evidence that I have been able, as yet, to find upon the subject, with the assistance of Dr. Rankin (a member of the committee), Dr. Bowditch, of Boston (late Chairman of the Mass.

State Board of Health), and Dr. Mackie, of New Bedford, Health Officer of that city. Dr. Rankin was kind enough to drive with me to the pond.

In the first place, and as general statements:

"As applied to sewage, disinfectants do not disinfect, and filter beds do not filter."—*Report of the First Rivers Pollution Commission, England.*

"No sewage of any kind, whether purified or not, should be allowed to enter any pond or stream used for domestic purposes. There should be absolute prohibition in all cases against casting sewage or filth of any kind into any stream or pond used as a source of water-supply. Where such conditions now exist, the sewage or filth should be diverted to some other channel. For, until our knowledge has so far advanced as to enable us to recognize 'germs' of disease, and to destroy them effectually by some simple and easy process, even purified sewage must always be looked upon as a dangerous addition to drinking water."—*General Report of Mass. Board of Health*, 1876, *p.* 12.

Now, as to ice:

1. The ice supply of Pittsfield, Mass., from "Silver Lake," one of the sources of the Housatonic River, came under suspicion in 1875. Several analyses were made, as follows, by Prof. Wm. Ripley Nichols, of the Mass. Institute of Technology:

DATE.	Free Ammonia.	Albuminoid Ammonia.	Inorganic.	SOLID RESIDUE.		Chlorine.
				Organic and Volatile.	Total at 212° Fahrenheit.	
Nov. 31, 1875.* *Water* from Lake.	.021	.020	10.28	2.60	12.88	.26
Feb. 16, 1876.† " "	.018	.0152	10.32	2.72	13.04	.30
" " ‡ " "	.022	.014	11.92	2.60	14.52	.35
" " § " "	.020	.0136	11.60	2.68	14.28	.38
Feb. 21, 1876. *Ice*, unfiltered..	.0072	.0061	.93	.58	1.51	—
" " " filtered....	.0077	.0013	.30	.14	.44	.02

* and † from surface, at middle of pond. ‡ Half way, between surface and bottom. § From bottom.

The sources of pollution were several dwellings and two factories, one of which emptied the overflow of a cesspool used by the employees. The pond covers about twenty acres.

Dr. Frederick Winsor, in charge of the "Water Supply, Drainage and Sewerage of Mass., from the Sanitary Point of View," thus sums up his report concerning this ice: "From the results of analysis, it will be seen that the ice is considerably purer than the water of the pond, thereby showing that the process of freezing does tend, to a considerable degree, to purification. Chemical examination alone does not indicate that the ice is unfit for domestic use, nor does it ordinarily detect a very slight degree of pollution, which may be offensive to our sense, from the fact that we previously knew of its presence. Considering (therefore) the great dilution of filth which may often take place without securing immunity from disease, consequent upon taking such filth into the system, there can be no question as to the propriety of putting a stop to this contamination at

once."—*Appendix to James P. Kirkwood, C.E., Special Report on the Pollution of Rivers, Seventh Annual Report Mass. State Board of Health.*

The evidence thus far is putative merely. That now given is positive.

2. At Rye Beach, N. H., there broke out during the summer of 1875, at one of the large hotels, an extensive, though strictly localized epidemic of fever, with both intestinal and general symptoms. A most rigid examination of the premises having failed to reveal any fault, the inquiry was committed to Dr. A. H. Nichols, of Boston, who had also charge of the cases of sickness. They were all traced to the use of ice from a pond, so identical in many of its conditions with Almy's Pond in Newport, that I quote the description:

"The pond is a flooded marsh of irregular outlines, about two-thirds of a mile in length, and varying in width from 200 to 800 feet, with a uniform depth of about two feet. There had formerly existed an artificial channel, by means of which was maintained a direct communication between the pond and the ocean; but this channel had been filled with sand and stones, thrown up during heavy storms by the action of the sea, which drives in here with extreme violence. Of late, therefore, the pond has become practically stagnant, although a small quantity constantly percolates a bank of gravel separating the pond from the ocean." Marsh mud and decomposing sawdust were the special faults found.

The following comparative tables give the results of the analyses, which, like those at Pittsfield, were made by Prof. Nichols, of the Mass. Inst. of Technology.

WATER FROM POND AT RYE BEACH.

COMPONENT PARTS.	Results expressed in parts per 100,000.	Results expressed in grains to U. S. gallon.
Ammonia	.0197	.0115
Albuminoid Ammonia	.0597	.0348
Inorganic Matter	64.96	37.88
Organic and Volatile Matter	8.	4.66
Total Solid Residue at 212° Fahr	72.96	42.54
Chlorine	34.	19.83
Equivalent to Chloride of Sodium	56.03	32.68
Oxygen required to oxidize organic matter	1.28	.75

ICE FROM POND AT RYE BEACH.

COMPONENT PARTS.	Results expressed in parts per 100,000.		Results expressed in grains to the U. S. gallon.	
	Unfiltered.	Filtered.	Unfiltered.	Filtered.
Ammonia	.0208	.0213	.0121	.0124
Albuminoid Ammonia.	.0704	.0165	.041	.0096
Inorganic Matter	7.80	6.88	4.55	4.01
Organic and Volatile Matter	5.72	2.84	3.33	1.66
Total Solid Residue at 212° Fahr	13.52	9.72	7.88	5.67
Chlorine	——	3.23	——	1.88
Oxygen required to oxidize organic matter	——	.334	——	.495

Dr. Nichols concludes his report thus:

"The notion that ice purifies itself by the process of freezing is not based upon trustworthy scientific observations. On the contrary, it is utterly wrong in principle to take ice for consumption from any pond the water of which is so fouled as to be unfit for drinking purposes."—*Seventh Mass. State Report, p.* 472.

To aid you in forming an opinion concerning the ice from Almy's Pond, after an analysis of the water and ice therefrom shall have been made, I append tables (the "mean of a number of determinations") showing the constituents of *Cochituate* water and ice (the Boston supply), usually noted for its purity.

COCHITUATE WATER.

COMPONENT PARTS.	Results expressed in grains to U. S. gallon.
Ammonia	.002
Albuminoid Ammonia	.0068
Inorganic Matter	1.61
Organic and Volatile Matter	1.22
Total Residue at 212° Fahr	2.83
Chlorine	.18
Equivalent to Chloride of Sodium	——
Oxygen required to oxidize organic matter	——

COCHITUATE ICE.

COMPONENT PARTS.	Results expressed in parts per 100,000.	Results expressed in grains to U. S. gallon.
Ammonia	.0045	.0026
Albuminoid Ammonia	——	——
Inorganic matter	.45	.26
Organic and Volatile matter	.31	.18
Total Solid Residue at 212° Fahr	.76	.44
Chlorine	Trace, less than .02	Less than .012
Oxygen required to oxidize organic matter	.033	.019

These tables will also aid you when examining those from Pittsfield and Rye Beach.

I have not pursued the second portion of the inquiry marked out in my previous letter to you (*i. e.*, whether seepage from a point distant an eighth of a mile could be neutralized during surface or subterranean flow), for the reason that at Almy's Pond there are similar and even greater sources of danger upon the very margin of the pond, a fact of which I was ignorant until informed of it by Capt. Cotton, and my own subsequent visit to the locality.

Yours sincerely, HORATIO R. STORER.

MR. BURDICK, Chairman of Ice Committee, Sanitary Protection Association.

APPENDIX C.

39 Washington Street, Newport, Jan. 1, 1881.

MY DEAR SIR: Having heard from other correspondents, permit me to render to you a supplementary report upon the question of the Almy's Pond ice.

I. My brother, who, as Prof. of Chemistry in Harvard University, has to keep himself familiar with everything that is done in these

matters throughout the world, writes me: "I do not remember to have seen any questioning of ice, as to impurity, excepting the work (analyses) of Prof. Nichols, to which you refer. I doubt if the subject has been much studied."

II. Col. Waring, Consulting Engineer of our Sanitary Association, says: "So far as my examination of the subject is concerned, the following seem to be the facts regarding the questions you submit to me:

"(1). Water containing the germs of typhoid fever does not free itself from such germs by congelation. This, I think, is well established.

"(2). Ordinary organic impurities, if uniformly diffused through water, are involved among the crystals of ice and appear in the water after the ice melts, in all respects unchanged. This also, I think, is clearly established."

III. Prof. Raphael Pumpelly, of the United States Geological Survey Bureau now established in Newport, and a member of our Association, expresses himself as follows:

"In answer to your questions I beg to say—

"1st. Water in freezing frees itself from substances which in *solution* with it give a fluid of greater specific gravity than water alone; but it still retains, even of these, more or less, entangled in the ice.

"Substances floating in suspension are entangled in the ice, and to this the microscopic low forms of life, among which are the infectious germs, form no exceptions.

"2d. Ordinary organic impurities are merely preserved from putrefaction during the period of their existence in a frozen condition. Freezing is only a temporary arresting of the processes of decomposition, and these are resumed when the requisite temperature is again attained.

"With regard to the effect of freezing on the specific characters of these low forms of life (the germs of infectious disease), we know that as germs they withstand a pretty good baking and freezing; but I think it is not yet settled whether they lose their infectious characters in these processes.

"In regard to the main question, it certainly seems to me that *no less* care is necessary in maintaining the purity of ice than of ordinary drinking water; indeed, one should suppose that greater care would be necessary, for the following reason:

"While, during the warmer season, the dead organic matter carried into streams and ponds is rapidly decomposed, or used up in nourishing plant and animal life, during the cold weather it tends to accumulate, and, owing to its lightness, it may well happen that the ice in forming may entangle so much of it and of bacteria germs (those of infectious disease), as to render the ice much more contaminated than a corresponding amount of drinking water (from the same source)."

In addition, important evidence has been given by these several gentlemen as to the third and fourth of my inquiries, which were, regarding the danger of contamination of a pond from the overflow of cesspools and the leakage of privies at a distance corresponding with that of the buildings of Messrs. Keene and D'Hauteville; but as there

are sources of danger, similar and equal to these, upon the immediate bank, in the case of Almy's Pond, I withhold the testimony referred to, as unnecessary for the present inquiry—reserving it, however, for the use of the Association, in case a similar question of the tainting of water, less easy in its decision than this, should hereafter occur.

The following may, however, in this connection, be quoted from Prof. Pumpelly's letter: "The experiments that we are now making, for the National Board of Health, prove that sand, in columns one hundred feet long, possesses absolutely *no* power to retain germs. And I think there is no doubt that what is true of one hundred feet is true of ten thousand feet."

The conclusions, therefore, as it seems to me, that may legitimately be drawn from the evidence we have now obtained, as to the safety of ice from Almy's Pond, are the following:

1. That while the *inorganic* impurities in water (mineral salts and the like), which are those ordinarily detected by chemical analysis, may be partially eliminated, through their specific gravity, during the process of freezing, the purification remains at the best but partial and imperfect. This was proved in the course of the investigations both at Pittsfield and at Rye Beach.

2. That the even more dangerous *organic* impurities resulting from human and other animal waste, are retained in ice unchanged as regards both quality and quantity, the latter indeed being likely to be increased. The privies and cesspools and large barn-yard of the settlement along the margin of Almy's Pond are covered by this statement.

3. That the germs of infectious disease, when this appears in such a locality, are retained in ice unaffected, and from their comparative lightness are so concentrated therein as to number, that they exist in even greater quantity than in the same amount of water, under similar circumstances, at other seasons of the year. The privies and cesspools of the Almy's Pond hamlet come under this head also.

4. That ordinary organic impurities thus retained in ice are likely, though there be no technically infectious disease is the neighborhood, to produce serious, and even dangerous illness in those persons who may use the ice in question for domestic purposes. This was positively proved at Rye Beach.

5. That though there may not occur a case of infectious disease in the vicinity of Almy's Pond for a considerable time to come, yet sooner or later it is quite certain to exist, and then to endanger the lives of all throughout the city, should there be such who should use the ice, more surely, indeed, than were they to drink the water alone.

The last are conclusions that can but imperfectly be affected by chemical analysis; the latter not at all, and hardly even by the microscope as ordinarily employed. It seems, however, the inevitable result of a reasonable, and indeed necessary induction, and to be, with that preceding it, the decisive points of our whole inquiry.

To the remarkable fact that the important subject that has been submitted to us proves a comparatively new question in science as well as in Sanitary Protection, it is unnecessary to more than allude.

I trust, however, that in view of this, and of the character of the expert evidence that we have received, you will be able to make at least a partial report at the next meeting of the Council.

Though the Ice Company might *intend* to use the ice of Almy's Pond only for the coarser purposes of their trade, yet in a season of scarcity like the last, which may at any time again occur, there would be great temptations to sell it for household purposes, and no reliable guarantee that such would not be done.

Sincerely yours, HORATIO R. STORER.

MR. BURDICK.

Upon acceptance of the above report, the following vote was passed by the Association:

"*Whereas*, An examination of Almy's Pond by a Committee appointed by this Association has shown that said pond receives a considerable amount of sewage, and

"*Whereas*, Chemical analyses of the ice and water of said pond show the presence of much organic material; and

"*Whereas*, Experiments made for this Association have shown that the germs of bacteria are not destroyed by freezing; and

"*Whereas*, An examination of Lily Pond has shown that body of water to be exceptionally free from any taint of sewage;

"*Be it Resolved*, That this Association recommend to its members that they for the present avoid the use of ice from Almy's Pond for any purpose; and

"*Be it further resolved*, That the Newport Ice Company be requested to have painted legibly on their ice carts, 'Almy's Pond' and 'Lily Pond' respectively, and that the Company be requested to agree to load each cart only with ice from the pond whose name it bears; and that the use of a Lily Pond cart to carry ice from Almy's Pond shall be considered a violation of the agreement between the Company and the Sanitary Protection Association."

The result has been that during the season of 1882 the residents of Newport received only Lily Pond ice, and that the Newport Ice Co. (April, 1882) have surrounded a large portion of Almy's Pond by an intercepting sewer, which, it is hoped, will hereafter afford sufficient protection.